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Semitendinosus and gracilis transfer for treatment of medial collateral ligament injury of total knee arthroplasty

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Abstract. – OBJECTIVE: The objective of the study is to evaluate the clinic effectiveness of semitendinosus and gracilis transfer for the treatment of medial collateral ligament (MCL) injury of total knee arthroplasty (TKA).

PATIENTS AND METHODS: From March 2009 to May 2014, a series of 11 patients with MCL injuries of primary TKA were treated by semitendinosus and gracilis transfer. Another 18 patients (21 knees) were recruited as control group. The two groups of patients were comparable for gender, age, body mass index, varus knee deformity, KSS score, joint activity degree and type of prosthesis comparison without significant difference ($p > 0.05$). All the patients were regularly followed-up using the American Knee Society Scoring System (KSS).

RESULTS: No patient of either group reported impaired wound healing, joint instability, pain, prosthesis loosening and other complications. At the final follow-up, the mean knee objective score and the functional score of the injury group include (89.82 ± 3.76) points and (89.54 ± 3.50) points, respectively. The control group includes (90.19 ± 3.39) and (90 ± 3.53) points. They were significantly higher than the preoperative conditions. The difference was not statistically significant. The difference of KSS score was not statistically significant ($t = 0.158$, $p = 0.877$; $t = 0.820$, $p = 0.432$).

CONCLUSIONS: The semitendinosus and gracilis transfer are reliable for the treatment of MCL injury of TKA. The semitendinosus and gracilis are close to the knee MCL, which can effectively improve knee function.

Key Words:
Semitendinosus, Gracilis, Total knee arthroplasty, Medial collateral ligament injury.

Introduction

Medial collateral ligament (MCL) is an important structure sustaining medial knee stability. The importance of total knee arthroplasty (TKA) for maintenance of post-operation joint function and prosthesis service life was supported by several reports[1-5]. The injury occurrence rate of MCL during TKA was reported in the range of 0.8%-2.7%, which can grow up to 8% among obese patients[5,6]. Unsatisfied intraoperative treatment of MCL may lead to joint instability and pain, as well as accelerated prosthesis wearing, which finally cause operation failure[7]. Currently, there lacks consensus about treatment for such injury. 1308 cases of patients with severe osteoarthritis of the knee with inversional deformity were treated with TKA from March 2009 to May 2014, among which 11 cases (11 knees) were reported with MCL injury, and reset with semitendinosus and gracilis tendon transposition. The clinical files of the 11 patients (injury group) were collected and compared with 18 patients receiving TKA during the same period but with not MCL injury. The clinical efficiency of the repair operation was analyzed to provide a future reference to similar cases.

Patients and Methods

Patients

The injury group included 2 males and 9 females aged 55 to 75 years old (average age of 64.3 years). 6 left knees and 3 right knees were involved with averaged duration of disease of 7.3 years, and body mass index (BMI) of 26.75 ± 4.21 kg/m^2. All the patients suffered from severe osteoarthritis with varus deformity. Pre-operative X-ray image achieved from full-length with double leg weight bearing suggested that the varus knee of 3-25° (average of 14.2°). Knee Society scoring system (KSS) based clinical score was (60.36 ± 12.51) points, and the function scores was (48.63 ± 12.26) points.

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The control group recruited 4 males (5 knees) and 14 females (16 knees) with age ranged 53 to 78 (averaged 63.7 years). Involved knees included 9 left and 6 right knees, and 3 patients with both sides involved. The duration of disease lasted from 0.5 to 21 years (averaged 6.6 years). Patients' BMI was (26.37 ± 4.29) kg/m^2. All the patients suffered from severe osteoarthritis with inversion deformity. The full-length weight-bearing X-ray image indicated of knee inversional deformity of 5-25° (averaged 13.5°). Knee Society scoring system (KSS) based clinical score was (57.81 ± 10.66) points, and the function scores were (47.27 ± 9.84) points.

The two groups of patients were comparable for gender, age, body mass index, varus knee deformity, KSS score, joint activity degree and type of prosthesis comparison without significant difference ($p > 0.05$).

Surgical Approach

Operations of both patients were performed by the same surgeon. Prosthesis applied to patients of injury group included 8 items of posterior cruciate ligament replacement prosthesis and 3 posterior cruciate ligament retaining prosthesis. For the control group, 16 items of posterior cruciate ligament replacement prosthesis and 5 posterior cruciate ligament retaining prosthesis were planted.

Operation procedure for the control group is described briefly as follows. Patients were anesthetized with continuous epidural anesthesia or combined subarachnoid block anesthesia. The anterior, middle incision was performed for the medial parapatellar approach. Preliminary release the soft tissue before excision or retaining posterior cruciate ligament based on the prosthesis type. Based on medullary and intramedullary positioning, we performed osteotomy to the distal femur and proximal tibia perpendicular to the coronal mechanical axis. Anterior and posterior condylar osteotomy was performed in parallel to the distal femoral condyle axis. The prosthesis was fixed with bone cement without placing negative pressure drainage tube. Then, the incision was closed.

For the injury group, the anesthesia method and the operative approach were similar to the control group. As described before, in case that medial clearance of the knee joint significantly becomes wider than the outer space after placing the prosthesis model, MCL injury is considered and MCL residue at the level of the joint line is examined. Except for one case with avulsion, all the other MCL injuries occurred on the joint level. Semitendinosus and gracilis tendon are searched around the proximal end of the tibia from the distal end of the median incision of the knee joint. The lateral tibial plateau is preserved. After separation with surrounding tissues, tendons up to 15 cm are removed using open tendon stripper and tissue shear. The tendons were weaved using Chinese Trap techniques for future use. The broken ends of the MCL were closed with over-and-over whip suture without knotting the line end. The knee prosthesis is fixed with bone cement. Knot the line tail after cement's fixation to maximally restore the integrity of MCL. The semitendinosus and the gracilis tendon are attached on the surface of MCL and closed with MCL with interrupted suture. On the femoral insertion side, the tendon was fixed with the femoral condyle and surrounding ligament using suture anchor or interface screw. The prosthesis was fixed with bone cement without placing negative pressure drainage tube. Then, the incision was closed.

Postoperative Treatment

For the control group, isometric contraction of quadriceps femoris, fixed function of the knee joint, and load walking were performed since day 1 after surgery to gradually recover the daily function. As for the injury group, fixed knee joint in extension position was maintained using a brace and the isometric contraction of quadriceps femoris, fixed function of the knee joint started since day 1. The brace was removed after 2 weeks followed by functional flexion exercise of knee joint with the flexion angle gradually increased. Unprotected load walking should be avoided at the beginning of recovery. The maximum knee flexion exercise should be realized after 6 weeks and also walk exercise with crutches started. Normal walking and daily function should be recovered after 3 months.

Statistical Analysis

SPSS22.0 statistical software (SPSS Inc., Chicago, IL, USA) was used for analysis. Data are expressed as mean ± standard deviation. The *t*-test was used in the comparison group, and the level of the test level a = 0.05.

Results

All cases got primary wound healing without complications such as infection, joint instability, pain, or prosthesis loosening. Patients of injury group and control group were followed up for 6-29 months (average 15.8 months) and 7-34 months (average 19.5 months), respectively. At the time of the latest follow-up, the KSS clinical scores (89.82 ± 3.76) points and functional scores (89.54 ± 3.50) points for the injury group were significantly higher than preoperative evaluation (t = 8.033, p = 0.000; t = 10.000, p = 0.000). The KSS clinical scores (90.19 ± 3.39) points and functional scores (90.00 ± 3.53) points for the control group were also significantly improved than before surgery (t = 11.065, p = 0.000; t = 16.413, p = 0.000). KSS scores and functional scores were comparable between the two groups (t = 0.158, p = 0.877; t = 0.820, p = 0.432). X-ray image review showed no prosthesis loosening or subsidence for both groups (Figure 1).

Discussion

MCL injury during TKA operation is mainly caused by releasing soft tissue when correcting inversion deformity; removing medial tibial plateau edge osteophytes or femoral condyle peripheral osteophytes; directly MCL injury caused by oscillating saw during tibial plateau osteotomy or removal of medial meniscus by electric knife or surgical knife. Although MCL is of critical importance to knee stability, MCL injury during TKA can be easily ignored due to latent nature or lack of experience of the operator. More attention should be paid to clearly diagnose MCL injury during TKA, which is featured with symptoms such as sudden full knee exposure during TKA procedure, easily spin-out of medial tibial plateau, and sudden increase of flexion gap[8,9].

Treatment for iatrogenic MCL fracture mainly includes repairing or strengthening of the broken ends and application of unconstrained prosthesis[10,11]. Other procedures have also been reported, for example, to implant thickened polyethylene gasket to patients without coronal instability[12]. Lee et al[6] compared the functional scores in patients with iatrogenic injury to the medial collateral ligament (MCL) treated with additional constraint to those without, and found that recognition of MCL injury during TKA is crucial, since using non-stabilizing inserts was associated with residual instability requiring revision. Results showed that the increased prosthetic constraints were revised for instability; no revisions for instability were performed in the 37 patients treated with additional constraint, indicating that conservative treatment resulted in a higher rate of revision, and constrained implants were a significant factor contributing to the better outcome of MCL injury during TKA procedure. The failure rate was higher among patients treated with posterior-stabilized (PS) implant than those with increased constraint. However, it has been mentioned by multiple studies that increased constraint of implanted prostheses would increase the stress of bone-cement and prostheses-bone interface, which easily cause prostheses loss[13]. Therefore, constraint implant should be avoided for conventional initial TKA, and how to repair the damaged MCL and restore the stability of the knee joint after surgery is particularly important.

The theoretical basis for applying semitendinosus and gracilis tendon transposition to repair MCL injury during TKA is that semitendinosus and gracilis tendon are anatomically close to knee MCL, which makes it possible for close attachment of knee MCL after removing both while remaining the tibial attachment. Therefore, anatomically friendly reconstruction of MCL using semitendinosus tendon and gracilis would maintain knee lateral stability and rotating stability[14]. It should be noted during the procedure that since the original knee MCL is of flat and wide strip shape, the linear semitendinosus and gracilis tendons would not completely replace MCL. Therefore, the endpoints of MCL should be closed with double seaming suture to repair the integrity of MCL, followed by attaching the implants on MCL surface, which effectively remain the medial stability of the knee joint[15,16]. 11 patients (11 knees) with MCL injury during TKA procedure were followed up by an average of 15 months and found no complications such as joint instability, pain, prosthesis loosening, indicating the satisfactory clinical outcome. Thus, semitendinosus and gracilis tendon graft assisted reconstruction avoided slow ligament healing after the operation, and meanwhile avoided application of constraint implant during initial TKA which may increase medical cost and risk of future reconstruction[13]. Suture anchor or squeeze nail can be implanted directly into the bone, making it easier for reconstruction of ligament and tendon attachment with good resistance to

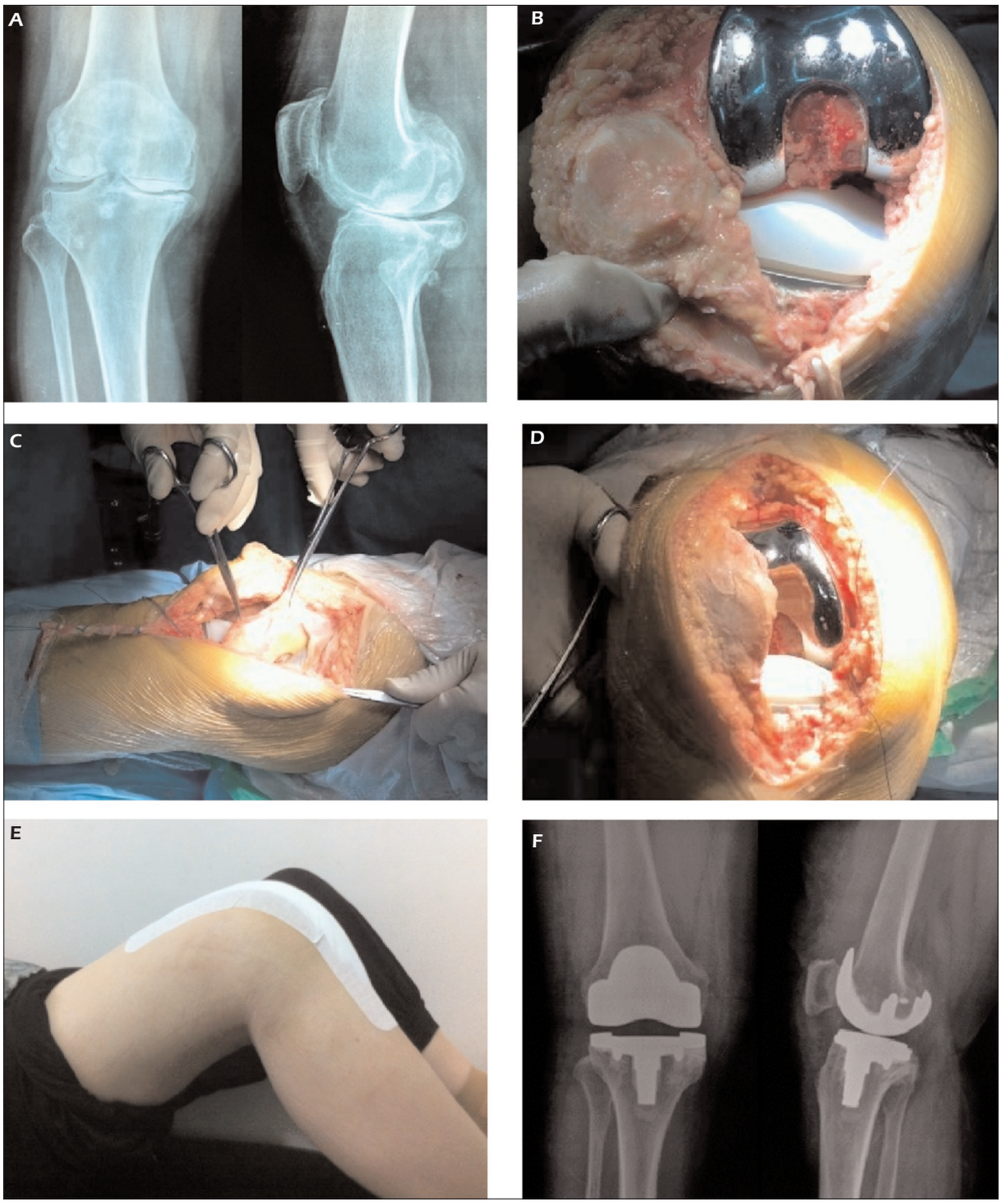

Figure 1. A female patient, 58 years old from the injury group, right knee osteoarthritis, undergoing TKA surgery with CR prosthesis. ***A,*** Preoperative X-ray; ***B,*** The medial joint space was significantly expanded after the prosthesis was installed; ***C,*** The two tendons were woven together by Chinese Trap knitting technique; ***D,*** Complete the transposition of the tendon and the tendon of the tendon, and the medial joint space disappeared; ***E,*** Two weeks after surgery, the knee joint flexion reached 90 degrees, and there was no medial instability; ***F,*** Six months after surgery, the right knee weight-bearing X-ray.

pull-out. Such design promotes patients to start knee recovery training sooner without affecting postoperative function recovery. Moreover, the histocompatibility of the suture anchor and the extrusion screw free patients from a painful experience, consequent to a secondary surgery to remove implants[17,18].

Conclusions

Injury of medial collateral ligament of the knee joint is a common complication of TKA procedure with no standard of treatment of MCL injury. It is recommended to better prevent rather than to treat intra-operative MCL injury by improving preoperative preparation and surgical techniques[19]. Furthermore, a better clinical outcome of MCL injury during TKA procedure can be realized by clearly determining injury degree and severity and selecting an appropriate treatment plan.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

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